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Papermaking Screen

The invention relates to a papermaking screen consisting of at least one single fabric for the paper side and at least one single fabric for the machine side, each consisting of a set of weft yarns and warp yarns and at least a part of the stacked individual fabrics being connected to each other by way of binder yarns.

Use is increasingly made today in the papermaking industry of high-performance papermaking machines running at speeds of up to 2000 m/min and with operating widths exceeding 10 m. As a very general rule, the sheet forming unit is configured as a twin-wire former, in many instances as a gap former. It is typical of the machines that the sheet forming process takes place immediately in a relatively short dewatering zone between two papermaking screens. The time for sheet formation is reduced to a few milliseconds because of this short distance and the high output rate. The solid content or dry content of the fiber suspension must be raised from about 1 percent to about 20 percent over this interval. This means for papermaking screens that they must possess high dewatering capability and yet must leave no marks in the paper and must provide high fiber support.

Another important point is the cross-directional stability of screen tension, which is decisive in determination of the thickness and moisture content profile of the sheet. Very high requirements have been set for this stability precisely in the case of modern machines operating with great sheet widths. Consequently, use is increasingly being made in the sheet forming zone of forming strips which are mounted on the machine sides of the screens and are pressed against them in order to improve the forming. This results in rapidly changing deflection of the fabric of the screens in the longitudinal direction.

There are basically two different approaches in the state of the art to solution of the problem of meeting these requirements, and in particular in order to effect binding together of the individual fabrics of the paper side and the machine side. One solution is characterized in that the two individual fabric layers are connected to each other together by means of a weft or transverse yarn. Another solution provides that the connecting is effected by means of a longitudinal or warp yarn. However, the approaches as disclosed are now out of the question above all if it is desired to employ different warp diameters on the machine and paper sides.

If the configuration of the two individual fabrics accordingly is oriented especially toward a fine paper side with small diameters and a coarse machine side with large diameters in order to arrive at high stability values, connecting of the two layers must be effected by means of a weft, a binding weft in particular. The state of the art offers corresponding proposals for solution of this problem as well.

Hence the possibility exists of interweaving the two individual fabrics by means of an additional binding or stitching yarn which belongs neither to the binding pattern of the upper fabric (paper side) nor to that of the lower fabric (machine side). A solution such as this is disclosed, for example, for the papermaking screen of US 5,238, 536, which provides a linen binding and a five-shank binding for the lower fabric. There are also approaches involving

additional stitching yarns which simultaneously effect connecting of the two fabric layers and in addition serve as filling threads. Such a solution is disclosed in US 5,518,042, for example.

In such disclosed solutions the additionally used binder yarns alter the inherently homogeneous upper side; in practical application this leads to some extent to undesirable marks in the paper. In order to counter this result the binder yarns are made to be increasingly thinner, but this has the disadvantage that the service life of the connection of individual fabric layers is correspondingly shortened. In addition, practical application has shown that Alooping through@ of the binding weft yarns may occur, this resulting in separation of the individual layers and rendering the fabric unusable.

In another disclosed solution complete upper wefts are replaced by pairs of binding structural yarns. Depending on the type of fabric, the ratio of true upper wefts made by weft or warp yarns to the binding weft pairs varies. For example, PCT publications WO 99/06630 and WO 99/06632 disclose fabrics in which the upper fabric is made as a type of linen binding by combining two binding weft yarns. The lower fabric in turn is in these disclosed solutions in the form of a five-shank binding.

Despite the good interconnection of the two individual fabrics, the disclosed solutions present the essential disadvantage that the upper warp of the paper side is not supported at the points of intersection of the binding wefts. If the course of a Acomplete@ upper weft in these solutions is considered, it is seen that both yarns are positioned at an elevated level as a result of alternate binding of upper weft and upper warp, with the result that both the warp and weft bends are positioned in one plane. As a result of use of the binding pairs this support is now absent from all intersections and all yarns absorb the main forces along their respective longitudinal axis which at the intersections is oriented in the direction of the interior of the fabric. This disadvantage of absence of support arises especially when upper weft and binding pair are

introduced in alternating sequence, so that, for example, a complete upper weft follows a binding pair which is then followed by a upper weft. In order then to produce the preferably disclosed linen binding, the following upper weft must extend above the warp yarn which was previously positioned above the intersection and as a result is additionally pulled into the interior of the fabric. The result is that either every other upper warp yarn is positioned deeper in the fabric or none of the warp yarns may be positioned at the level of the weft yarns. This leads to uneven progress of the fabric on the paper side, something which may result in undesirable marks in the paper.

On the basis of this state of the art the object of the invention is to avoid the disadvantages in the state of the art as described, and in particular to provide a papermaking screen which is characterized by high stiffness values, in particular a high degree of cross-directional stability, and which affords dewatering output comparable to that of the disclosed solutions and helps prevent formation of marks in the paper. The object as thus formulated is attained by a papermaking screen having the characteristics specified in claim 1 in its entirety.

In that, as is specified in the characterizing part of claim 1, the respective binder yarn extends above warp yarns of the individual fabric at specific points on the paper side, below which at least one weft yarn of this individual fabric extends on the opposite side, connection of the two fabric layers (paper side and machine side) is in turn effected by means of binder yarns which are then nevertheless fully integrated into the fabric structure of the paper side and in the process support the binding point by the special type of connection in such a way that the binder yarns remain on one plane with the wefts and the remaining warp yarns. Application of this binding concept results in production of a papermaking screen having a high degree of stiffness, possessing good dewatering properties and uniform structure, on the paper side in particular, so that undesirable marks in the paper are prevented.

As a result of the solution claimed for the invention, the warp yarns are supported from below by the associated weft yarns of the individual fabric of the paper side at points at which the warp yarns are pulled into the interior of the fabric by the binder yarn. The functional separation of upper and binding weft also makes it possible to employ for the upper weft (paper side) a material which supports the cross-directional stability of the fabric, such as a polyester material, while both materials are of the same type in the solutions referred to in the foregoing in use of a binding weft pair and require optimization with respect to connection of the layers, use customarily being made of polyamides. Although only one binder yarn is used in a given plane considered in the solution claimed for the invention, the number of binding points, and accordingly contact between binding weft and upper and/or lower chains of paper side and machine side, are not reduced in comparison to the disclosed solutions.

In one especially preferred embodiment of the papermaking screen claimed for the invention, provision is made such that the diameter of the binder yarn corresponds to that of the upper weft, this resulting in a high degree of stiffness of binding of the fabric layers.

Other advantageous embodiments of the papermaking screen claimed for the invention are specified in the dependent claims. The papermaking screen claimed for the invention will be described in detail below with reference to the drawing, in which, in the form of diagrams not drawn to scale,

FIGS. 1 and 2 present in the form of sectional diagrams two binding solutions disclosed in the state of the art,

FIG. 3 a top view of a section of the upper or paper side of the papermaking screen claimed for the invention,

FIGS. 4 and 5 sections along lines A-A and B-B in FIG. 3,

FIG. 6 a top view of the upper or paper side of a second embodiment of the papermaking screen claimed for the invention,

FIGS. 7 and 8 sections along lines C-C and D-D in FIG. 6,

FIG. 9 a top view of the upper or paper side of a third exemplary embodiment corresponding to the first exemplary embodiment, but executed with alternating weft sequence of the upper and binding weft.

In addition, the following numeral identifications are employed in all the illustrations:

1 upper warp

2 upper weft (with binding weft)

3'3 binding weft

4 upper weft

5 lower warp

6 lower weft

7 extension above

8 extension below

9 extension above through lower weft 6

In the disclosed solution in the state of the art illustrated in FIG. 1, the papermaking screen as viewed in the line of sight to FIG. 1 consists of two individual fabrics, the upper individual fabric or upper fabric forming the paper side and the individual fabric positioned below it representing the bottom side or lower fabric. The upper individual fabric consists of a set of weft yarns 2 as upper weft yarns and warp yarns 1 as upper warp yarns. The machine side located underneath also consists of a set of weft yarns 6 as lower weft yarns and warp yarns 5 as lower warp yarns. The disclosed solution has a linen bond as the binding type for the paper side and the lower fabric is configured as a five-shank fabric with respect to a repeat. As FIG. 1 shows, the two individual fabrics are connected to each other by way of a binding weft yarn 3, a plurality of such binding weft yarns (not shown) being positioned in sequence so as to extend into the plane of the drawing and out of it and thus the connection of the individual fabric layers necessary for the papermaking screen is effected. In these disclosed solutions the binder yarns 3 are used in the direction of the fabric in advance of and beyond the upper weft yarns 2 in order to effect connection of the individual fabric layers, with the result that the actually very homogenous upper side of the paper side of the screen is altered to disadvantage in such a way that in practical application undesired marks may appear in the paper. In order for the disclosed binding weft yarns 3 accordingly to be disturbed as little as possible, they are made to be increasingly thinner, so that, when the disclosed papermaking screens are used, separation of the individual fabric layers may occur and accordingly failure of the screen as such.

In the other disclosed solution shown in FIG. 2 two binding weft yarns 3 and 3' accordingly are used the diameter of which in particular is selected to be greater than the

diameter of the disclosed binding weft yarn 3 shown in FIG. 1. As a result of use of the two binding weft yarns 3 and 3" no complete upper weft is present then in these places any longer; the linen binding of the upper side rather is effected through combination of the two binder yarns 3, 3'. In this instance as well only a part of the papermaking screen is shown in section and a plurality of binder yarns 3 and 3' are present in sequence in different possible drawing planes. A significant disadvantage is to be seen in this disclosed solution in that the upper warp yarns 1 are not supported at the intersections of binder yarns 3 and 3'. In the case of this solution as well irregularities occur and accordingly also marks in the paper with respect to the paper side of the screen, since, in order for the linen binding to be effected, the next upper weft must extend above the warp yarn, which previously was positioned above the intersection and consequently in addition is pulled into the interior of the fabric. Consequently, either every other upper warp yarn is positioned deeper in the fabric or none of the warp yarns are at the level of the weft yarns, and this situation results in the disadvantages described.

The papermaking screen claimed for the invention will now be described below; for the sake of simplicity and greater ease of understanding the same reference numerals are used for the following illustrations of solutions as for the disclosed solutions described in the foregoing.

The first exemplary embodiment of a papermaking screen as shown in FIGS. 3, 4, and 5 is provided on the paper side with linen binding and on the lower side or machine side is configured as a five-shank bond. FIG. 3 presents a top view of a section of the upper or paper side of the papermaking screen claimed for the invention and section A-A shown in FIG. 4 is presented as a view of the upper weft without binding weft, while section B-B is a view of the upper weft with binding weft as shown in FIG. 3.

FIG. 5 in particular shows how connection of the two individual fabrics for paper and machine side is effected by way of binder yarns 3; by way of example the progress of such a binder yarn 3 is shown in the form of a section in FIG. 5. This binder yarn is fully integrated

into the fabric structure on the paper side, in that on the paper side the respective binder yarn 3 extends above the associated warp yarns 1 of the individual fabric at specific points, at least one weft yarn 2 of this individual fabric extending below these warp yarns 1 on the side opposite the latter. This extension above or below is indicated in FIG. 5 by reference numerals 7 and 8. As a result of such arrangement, in which the associated binder yarn 3 extends above a warp yarn 1 and the associated upper weft yarn 2 extends below it, the binding point is supported from the direction of the opposite side, this ensuring that this binding point will remain on one plane with the other weft and warp yarns 4 and 1. Consequently, the upper weft yarn 2 also extends uniformly at the point at which the fabric binding has been effected without being bound into the lower fabric. Only at points at which the binding weft 3 extends above the upper warp is a brief exchange of upper weft 2 and binding weft 3 carried out. As a result, the warp yarns 1 positioned in between are supported from below by the upper weft yarn 2, as seen in the line of sight to FIG. 5, at the points at which these yarns 1 are pulled through the binder yarn 3 into the interior of the fabric, a contribution also being made to support by the warp yarns 5, of greater diameter, of the lower weft 6, especially the lower warp yarn 5, which is positioned vertically below the warp yarn 1 above and below which binder yarns extend.

As is also to be seen in FIG. 5, the respective binding weft yarn 3 defines at the point of extension above 7 of the associated warp yarn 1 an angle with the latter, the measurement of which equals that of the weft yarn 2 extending below at this point. These angular measurements range from 90° to 130° in these areas, as a function of the configuration of the papermaking screen. As a result of these angular measurements a sort of roof pane is created, both on the side of extension above 7 and in the opposite direction at the point of extension below 8. This situation has a favorable effect with respect to the binding pattern and the overall pattern of forces of the papermaking screen.

The binding solution claimed for the invention, configured as a five-shank binding with respect to a repeat, provides that the weft yarns 6 extend below four warp yarns 5 and above a following warp yarn 5, the respective binding weft yarn 3 rises obliquely from the lower fabric to the upper fabric at the point of this extension above 9. The respective binding weft yarn 3 is essentially of the same diameter as that of the respective weft yarn 2 of the individual fabric on the paper side. In addition, the warp yarns 5 and weft yarns 6 of the lower fabric, that is, on the machine side, are of a diameter larger than that of the associated yarn systems on the upper or paper side of the papermaking screen. With respect to the upper or paper side of the screen, the respective extension above 7 of the respective binder yarn 3 is separated in sequence from a weft yarn 2 by three warp yarns 1 positioned between them, at the point of the center warp yarn 1 of this group of three the binding weft yarn 3 executing extension below 6, a short distance in advance of the extension above 9, a warp yarn 5 positioned underneath. As a result of the functional separation of upper weft yarns 2 of the upper fabric and binding weft yarns 3, these two sets of yarns may consist of different materials; by preference the upper weft yarns 2 consist of a polyester material and the binding weft yarn 3 of a polyamide material, for the purpose of increasing the cross-directional stability of the screen.

The upper weft yarn 4 shown in FIG. 4 corresponds in configuration to the upper weft yarn 2 with binding weft yarn 3 positioned upstream from it as illustrated. The difference in numbering was selected exclusively for the sake of better understanding of the top view of the fabric pattern shown in FIG. 3.

In the case of the modified embodiment shown in FIGS. 6, 7, and 8, this embodiment corresponds largely to the first embodiment initially described, except that a four-shank binding was used here for the lower fabric or lower side (machine side) in place of a five-shank lower side. In the respective four-shank binding shown in FIG. 8 the warp yarn 1 above which the binder yarn 3 extends and below which upper weft yarn 2 extends is in turn supported by a warp

yarn 5 positioned below it of the lower fabric, the lower weft yarn 6 extending above the lower warp yarn 5 at the point of support. The binder yarn 3 is then tied in for the lower fabric in the area of three consecutive lower warp yarns 5, the binder yarn 3 extending above the central lower weft yarn 5 of a group of three and above two adjacent lower warp yarns 5. The roof-like configuration in the area of extension above 7 for the upper warp yarn 1 has corresponding to it in parallel a configuration in the form of extension 9 of the lower weft yarn 6 above the supporting lower warp yarn 5.

In the embodiment illustrated in FIG. 9 the sequence of upper weft 2 with binder yarn 3 is changed, with the result that all floats of the warp yarns 1 are of the same length L on the upper side despite the arrangement of the binding points so as to be easily displaced toward each other. This makes certain that the warp bends are positioned in one plane on the upper side, in both the transverse and the longitudinal directions; this has a favorable effect in view of slight possible marking of the paper and of the high degree of stiffness of the screen. A high degree of stability is achieved with the papermaking screen solution claimed for the invention; the screen is characterized by very good dewatering output and its production is cost-effective.